

# Image Processing Applied to Environmental Characterization

## Energy and Environmental Analysis Group (TSA-4)

### Los Alamos National Laboratory

#### Introduction

Los Alamos has been utilizing image processing to characterize environmental problems and surface features at DOE sites and other project areas. Our Image Processing Laboratory is well equipped to make use of many different types of data including digital multispectral satellite imagery, maps, and aerial photography. Hard copy data like maps and photos are turned into digital data by scanning, enabling them to be processed on a computer in ways which are impossible manually. The main software used by the Laboratory is the Map and Image Processing System (MIPS) developed by MicroImages of Lincoln Nebraska\*. It is a powerful and easy to use analysis package which provides image processing, a Geographic Information System (GIS), and database capabilities. Some examples follow.

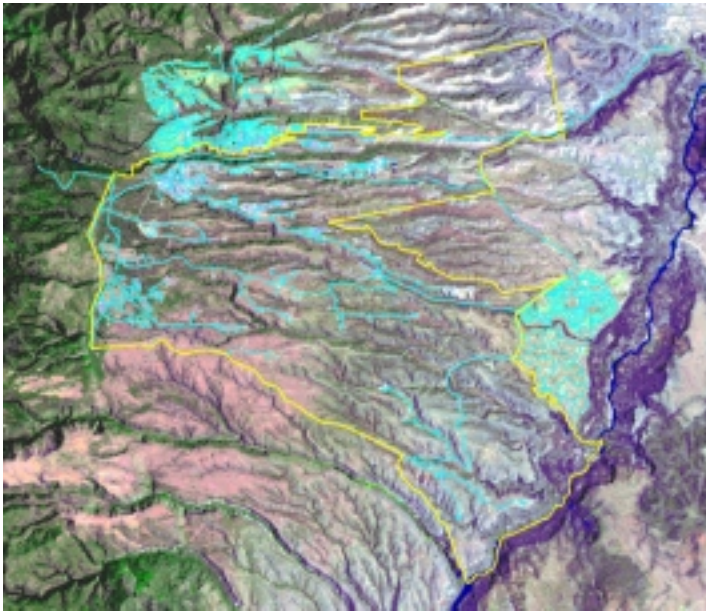


Fig. 1. Landsat false color imagery of Los Alamos New Mexico with overlays of the LANL boundary and paved roads.

#### Characterization of DOE Waste Sites Using Remotely Sensed Imagery and Spatial Analysis within a GIS

The DOE is involved in Environmental Restoration efforts to clean up waste sites found at its complexes. Part of this task is to characterize the sites in terms of location, extent, and contents of the waste. Los Alamos has been working closely with the Environmental Research Institute of Michigan (ERIM) and others to show how the synergy between Remote Sensing and a Geographic Information System can aid in characterizing waste

sites. Multitemporal Landsat imagery can provide a history of physical change at waste sites. SPOT sharpened Landsat imagery provides images at scales comparable to aerial surveys. These types of analyses could be used for postremediation monitoring. Geographic Information Systems were designed to handle spatial data, such as line maps and images, efficiently (see Fig. 1) and provide for rapid spatial analysis of the layers of information within it. Spatial analysis within a GIS could provide for the integration of all spatial data related to a waste site to aid in its characterization.

#### Digital Analysis of Historical Airphotos to Aid Environmental Remediation Efforts at Los Alamos National Lab

Aerial surveys of the Los Alamos area have been collected every decade since 1930, and the digital analysis of these photos can better locate "fuzzy" waste sites, provide a temporal history of physical change, and aid in postremediation monitoring. Aerial photographs of the MDA-F site (shown at right in Fig. 2) were collected from 1935 to 1991. These historical photographs were digitized by scanning, and then rotated, stretched, and coregistered to directly overlay our 1991 orthorectified photo. These digital images were then differenced, which highlighted areas of greatest change in features. The aerial extent of trenches or other attributes could then be located, as indicated in fig. 3.



Fig. 2. Recent aerial photo of Los Alamos showing an old material disposal site (MDA-F) at Los Alamos. The site is located just above and parallel to the road. The central part of the laboratory is shown in the upper left. This picture is looking to the northeast.

\*Mention of brand names does not constitute an endorsement of these products by LANL.

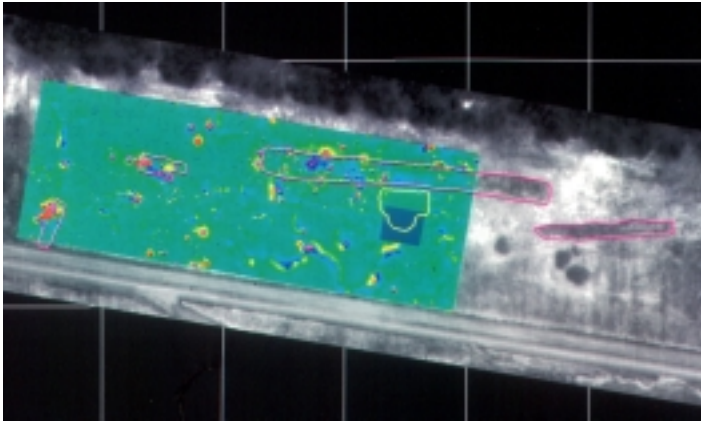


Fig. 3. Results of the combination of a variety of data at the MDA-F site. Locations of features are overlain on a 1958 aerial photograph of the site. Two sizable pit boundaries were delineated (in red), plus a variety of other smaller pits and objects. Most notable is the overlay in green, which shows the extent and results of a magnetic survey over part of the area. Note that the survey does not cover both red pits, since it was laid out prior to seeing the results of the historical photography.

#### **Creation of a Land Cover Map to Aid Air Quality Modeling of Mexico City**

Air quality in and around Mexico City is currently being evaluated by Mexican and Los Alamos scientists to predict the effectiveness of various remediation scenarios. Los Alamos is creating an atmospheric model for the region in support of this effort. One input to this model is land cover, which will drive the land-air coupling algorithm of the model. Landsat TM data of Mexico City was used to derive a current, digital land cover map of the city and surrounding regions. This very detailed classification map was then resampled to the resolutions appropriate for their model. Figure 4 shows the Landsat image used in this classification.

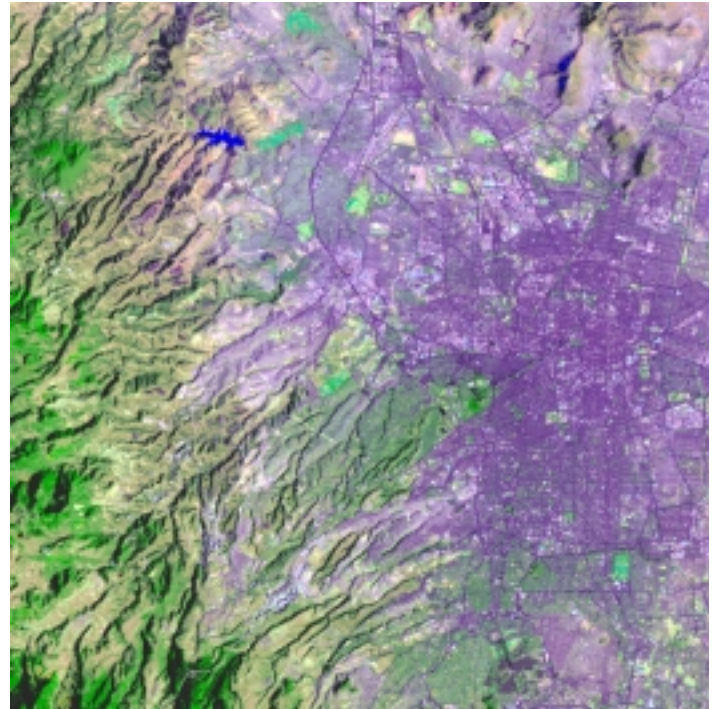


Fig. 4. Landsat image (Bands 741) of Mexico City.

#### **Updated access map for Nevada Test Site Area 20**

Seismologists needed an up-to-date map of Area 20 at the Nevada Test Site in order to place their instruments for an underground test. A High Altitude Photo (HAP) of the area was digitized, geocoded, and resampled to a suitable projection. Roads, trails, and areas of disturbed land were extracted from the digital image as vector data so that it could be overlaid on the digitized photo, or used to create a separate line map of the area. The finished accessibility map (Fig. 5) showed many more trails and roads than an older hand drawn one.

#### **For Further Information, Contact**

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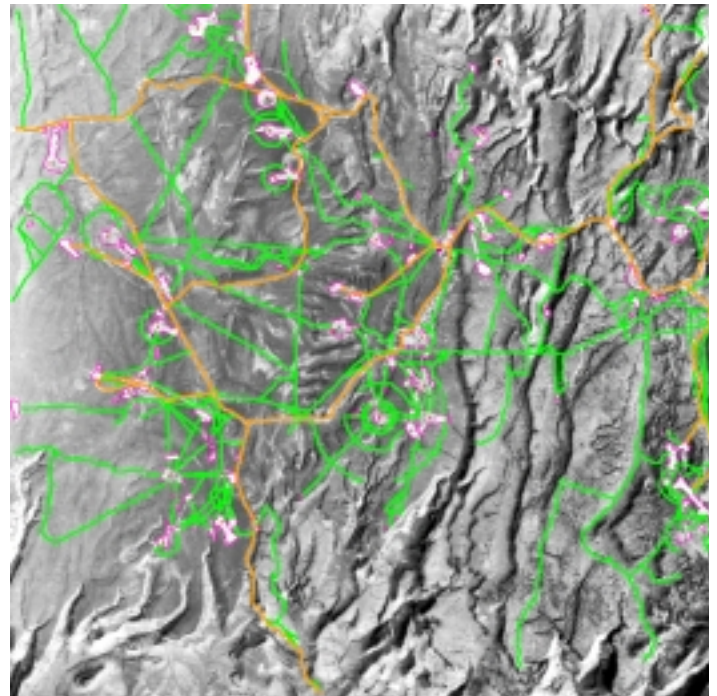


Fig. 5. HAP photo of NTS Area 20, overlaid with the road map generated from it.